



00-PPMI-123

Lead Center POP 00 Recommended Mark Review

**Human Space Life Sciences Programs Office**  
**“Transitioning to the Bioastronautics Initiative”**

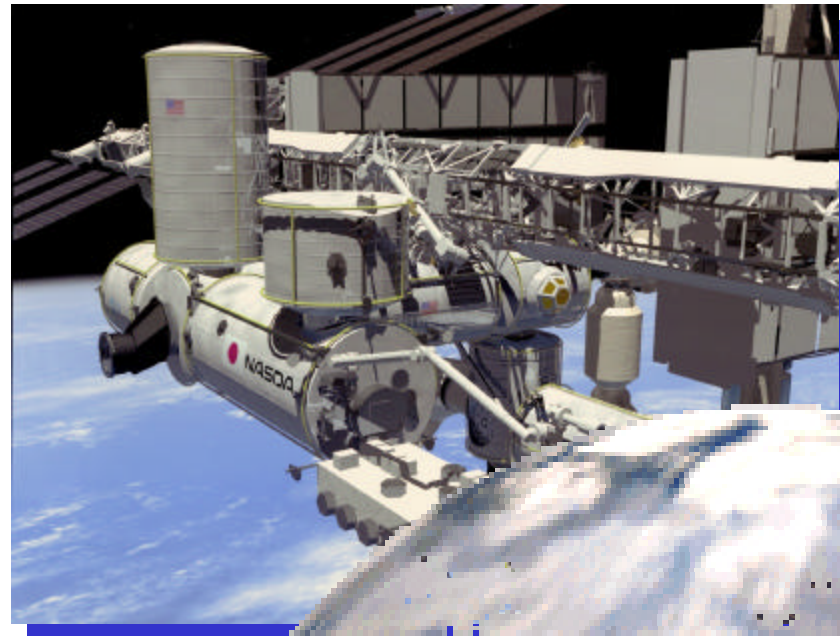
**Space Medicine**  
**Biomedical Research and Countermeasures**  
**Advanced Human Support Technology**  
**Microgravity Research**

Charlie Stegemoeller  
Manager, JSC Human Space Life Sciences Programs

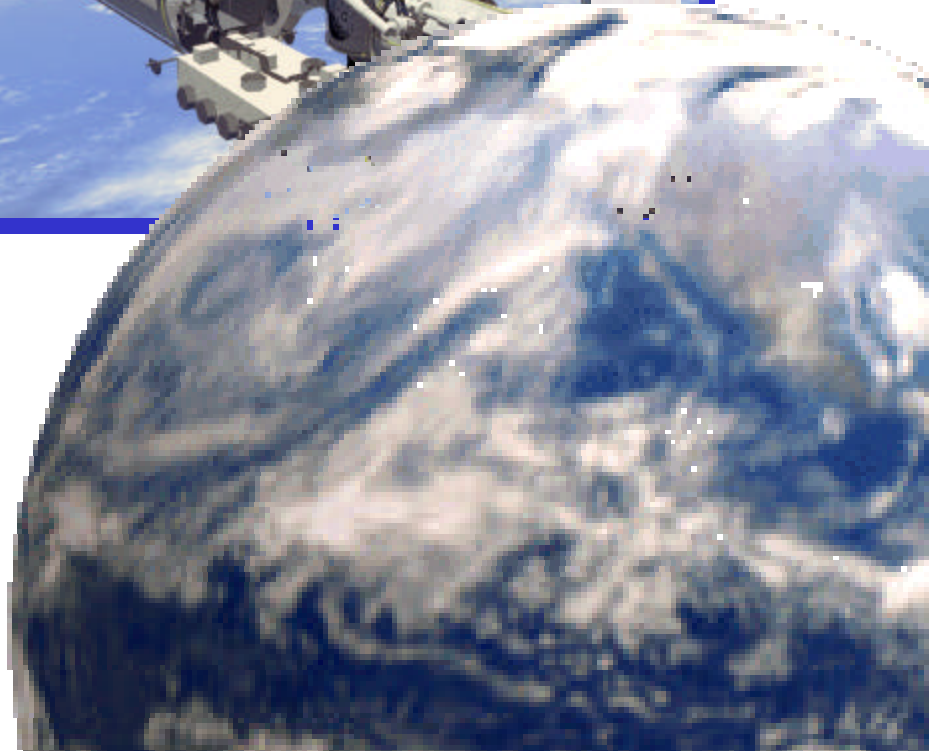


## Bioastronautics - Goal

*Ensure and  
enhance the  
health, safety,  
and  
performance of  
humans in  
space\**



\* HEDS objective  
identified in the  
NASA 2000  
Performance Plan





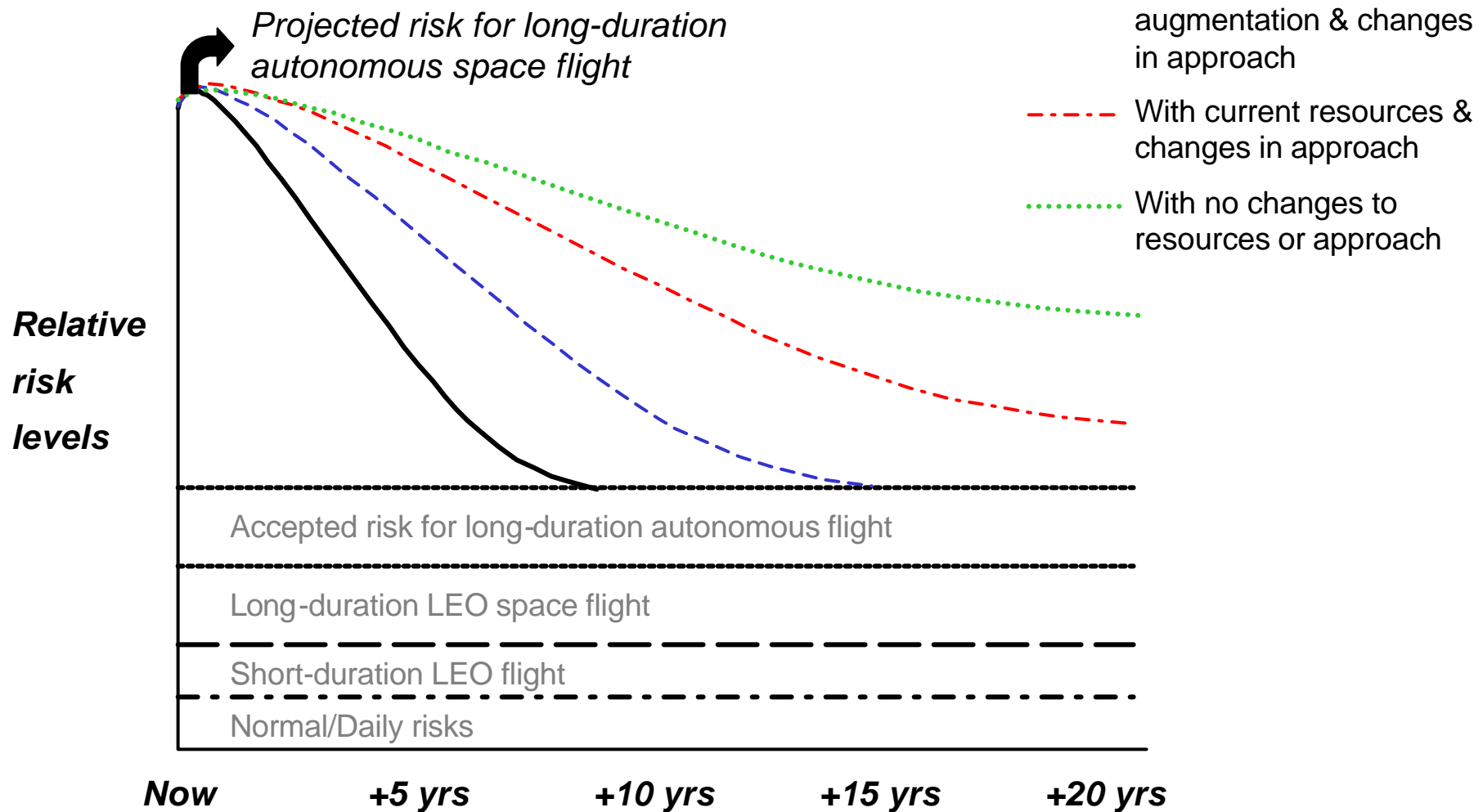
# Where Are We Headed?

## Degree Of Medical Services Required

	1999	2006	2010
Pre-flight	Preventive Care	Preventive Care	Preventive Care
In-flight	Health Maintenance & Intensive Monitoring	Health Maintenance & Intensive Monitoring	Preventive Care
Post-flight	Medical/Critical Care	Health Maintenance & Intensive Monitoring	Preventive Care



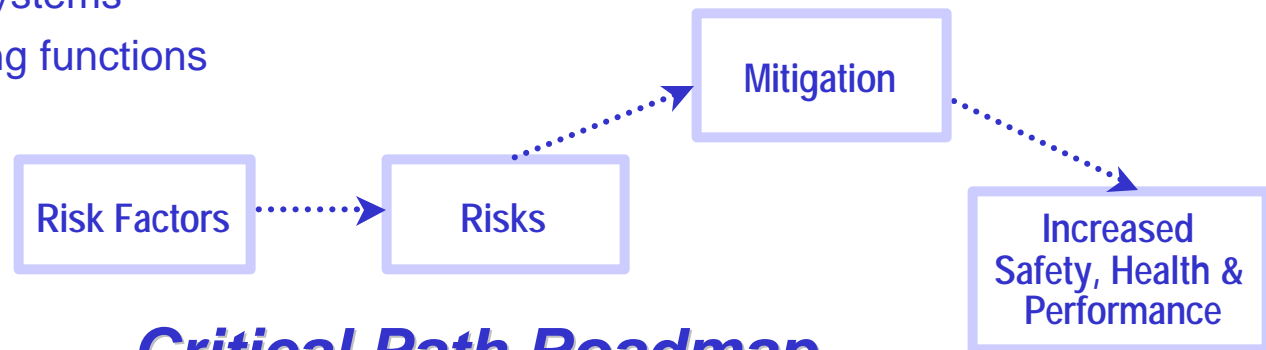
## Projected Risk Levels (Conceptual)





## Transition to Bioastronautics Initiative

- Fiscal Years 00 and 01 are the transitional years
- Bioastronautics Augmentation was included in the FY01 Presidential Budget Submit - 30% of requested value
- This POP initiates Bioastronautics
  - Requires a rebalance of the overall program based on the final augmentation/targets
- Augmentation elements
  - Health care system
  - Habitation/environmental factors
  - Human adaptation/countermeasures
  - Biological systems
  - Cross-cutting functions



***Critical Path Roadmap***



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## Human Space Life Sciences Programs Office

### POP 2000 Recommended Bioastronautics Program

	FY01	FY02	FY03	FY04	FY05	FY06
<b>TOTAL PROGRAM</b>						
Guidelines	120.0	127.8	132.8	138.9	138.1	138.1
Recommend	166.0	203.2	229.7	251.5	261.2	269.2
<b>Delta</b>	<b>46.0</b>	<b>75.4</b>	<b>96.9</b>	<b>112.6</b>	<b>123.1</b>	<b>131.1</b>

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<b>OVERGUIDELINES</b>	<b>46.0</b>	<b>75.4</b>	<b>96.9</b>	<b>112.6</b>	<b>123.1</b>	<b>131.1</b>
Habitability and Environmental Factors	6.2	15.1	17.7	23.2	21.9	21.2
Adaptation/Countermeasures	15.7	21.3	22.5	19.9	19.6	15.4
Space Medicine & Health Care Systems	5.9	5.7	3.4	3.6	3.6	3.4
Biological Systems	0.0	0.0	5.0	6.0	8.0	8.0
Cross Cutting Functions	18.3	33.3	48.3	59.9	70.1	83.1

*Note: Guidelines includes Bioastronautics Augmentation at 30% and Recommend at 100%*



## Bioastronautics Augmentation Budget – BRC

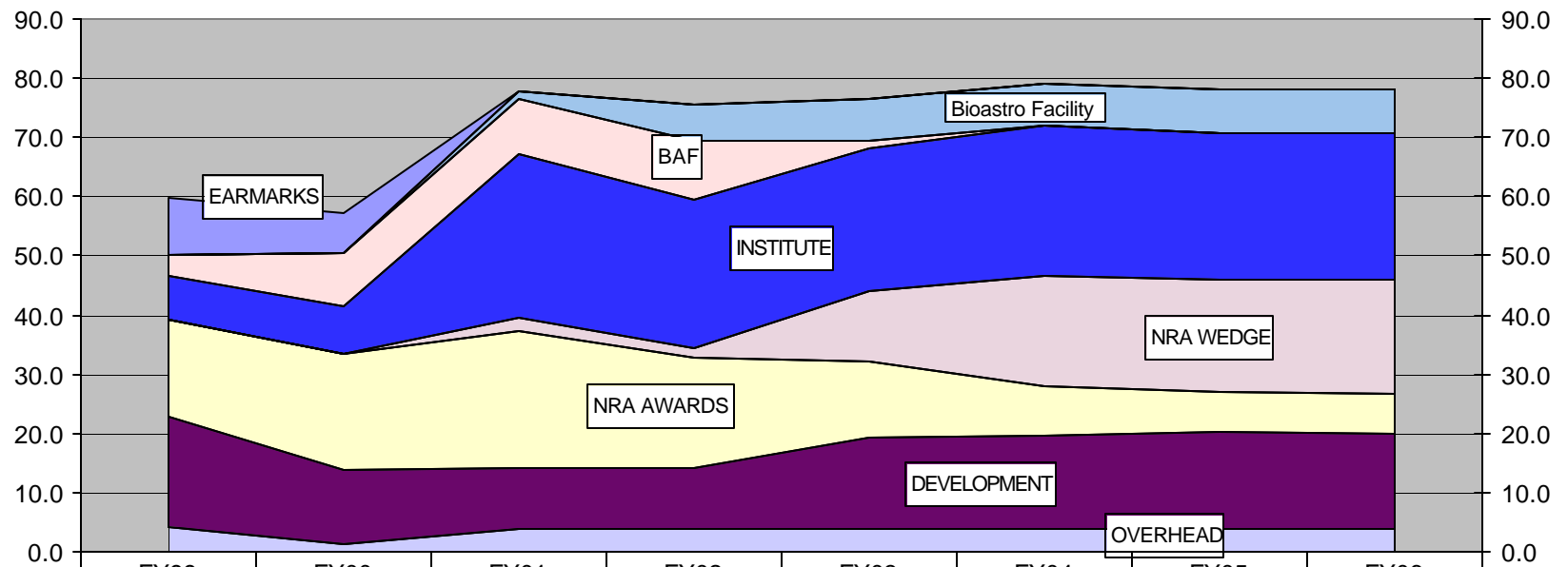
### Summary of Content Distribution

	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
<b>POP 00 GUIDELINE MARK</b>	<b><u>19.0</u></b>	<b><u>17.2</u></b>	<b><u>18.2</u></b>	<b><u>19.2</u></b>	<b><u>18.2</u></b>	<b><u>18.2</u></b>
<i>Allocated to Projects:</i>						
NSBRI	9.7	9.7	9.7	10.7	10.7	10.7
Program Implementation (BA Facility)		6.2	7.2	7.2	7.2	7.2
<i>Applied to Content:</i>	<u>9.3</u>	<u>1.3</u>	<u>1.3</u>	<u>1.3</u>	<u>0.3</u>	<u>0.3</u>
NSBRI 2.5% HICS Tax <i>(Applied to Biomed Research)</i>	0.3	0.3	0.3	0.3	0.3	0.3
BI Program Implementation						
- 99 HEDS 03 Selections	3.9	0.6				
- RPP Risk Mitigation	0.5					
- RPP Task planning	0.5					
- FY00 NSBRI Payback	1.0					
- Architectural Study FY01	1.3					
- HQ's 1% Contingency		0.4				
BI Ground Simulations						
- BIO-Plex Utilization	0.4		0.4	0.4		
- BIO-Plex Development	0.5		0.6	0.6		
- EC Program Transfer to UPN 131						
- Futron NRA	0.4					
- Other BRC	0.5					



## POP 00 Recommended Budget – BRC

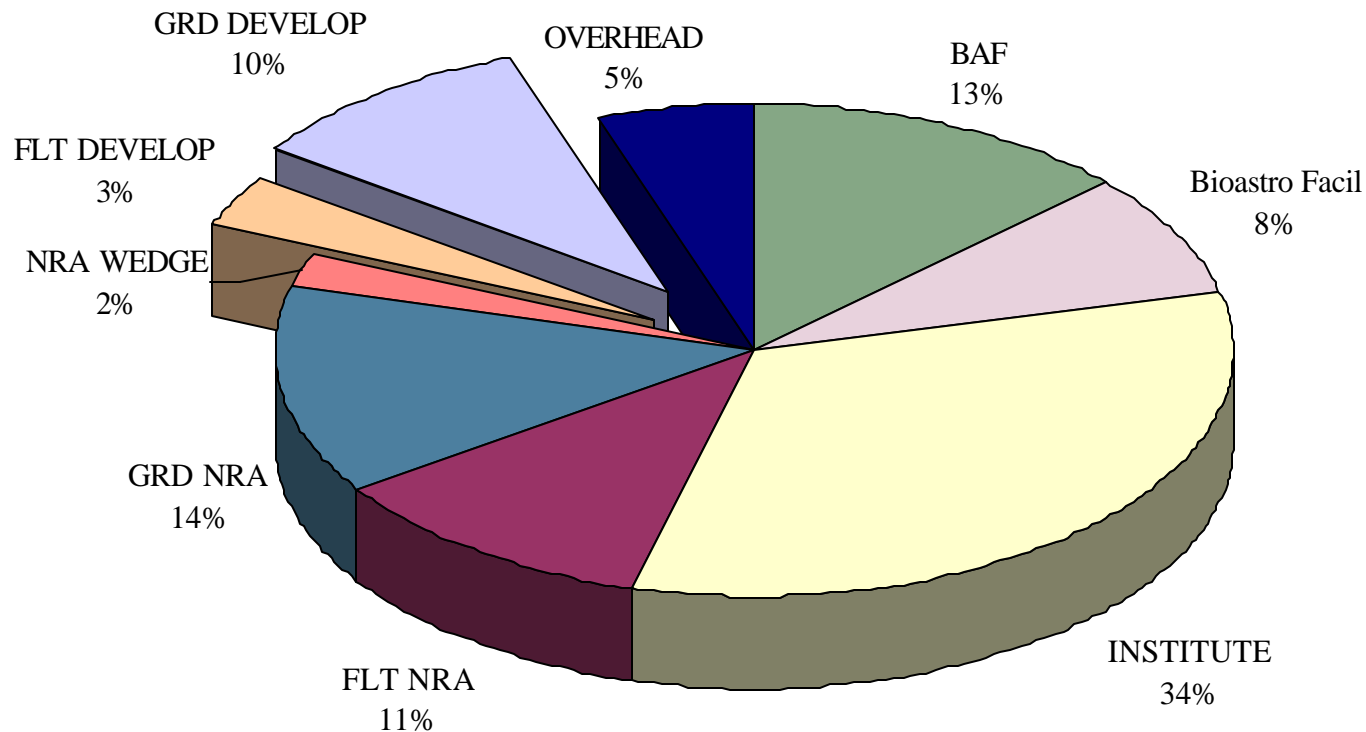
### Summary of Content Distribution



	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06
EARMARKS	9.7	6.8	0.0	0.0	0.0	0.0	0.0	0.0
BIOASTRO FACIL	0.0	0.0	1.3	6.2	7.2	7.2	7.2	7.2
BAF	3.5	9.0	9.5	9.8	1.0	0.0	0.0	0.0
INSTITUTE	7.2	8.0	27.4	25.0	24.2	25.2	24.8	24.8
NRA WEDGE	0.0	0.0	2.3	1.7	12.0	18.8	18.9	19.2
NRA AWARDS	16.5	19.5	23.2	18.7	12.9	8.4	6.8	6.8
DEVELOPMENT	18.7	12.6	10.3	10.2	15.3	15.8	16.5	16.2
OVERHEAD	4.1	1.3	3.9	3.9	3.9	3.8	3.8	3.8
TOTAL	59.7	57.2	77.9	75.5	76.5	79.1	78.0	78.0



## BRC POP 00 Recommended Budget – FY02 Content



BAF	9.8
Bioastro Facil	6.2
INSTITUTE	25.0
FLT NRA	8.4
GRD NRA	10.3
NRA WEDGE	1.7
FLT DEVELOP	2.5
GRD DEVELOP	7.7
OVERHEAD	3.9
<b>TOTAL</b>	<b>75.5</b>

<b>Ground Development:</b>	<b>7.7</b>
- Coop Cardio Re NHLBI	1.2
- BNL AGS/BAF Usage	1.1
- Human Frontier	0.5
- USRA Coop Proj.	0.6
- KC-135 Activity	0.3
- Prog Mgt, Plan & Integ	1.1
- Prog Advoc/Outreach	1.3
- Spaceline Support	0.7
- Workshops	0.2
- UL Lead Scientist(IPA)	0.6
- Mgmt Support/Studies	0.1

<b>Flight Development:</b>	<b>2.5</b>
- CEVP ITR Dev	1.3
- CEVP Proj Integ	0.6
- ISS/STS-107 PES	0.4
- Small Payload Integ	0.1



Human Space Life Sciences Programs Office (HSLSPO)  
POP 00 Recommended Mark Review

June 18, 2000

## Total OLMSA - Bioastronautics

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
TOTAL							
NOA\$	94.4	120.0	127.8	132.8	138.9	138.1	138.6
Civil Service FTEs	96.0	101.0	106.0	119.0	119.0	119.0	119.0
Support Contractor EPs	224.4	223.0	204.7	200.7	203.6	201.6	201.6
Ames Research Center							
NOA\$	5.5	4.7	4.1	5.3	5.4	5.4	5.4
Civil Service FTEs	24.0	27.0	27.0	29.0	29.0	29.0	29.0
Support Contractor EPs	24.8	24.8	24.8	24.8	24.7	24.7	24.7
Goddard Space Flight Center							
NOA\$	3.5	2.5	0.7	0.3	0.1	0.1	0.1
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headquarters							
NOA\$	6.0	8.1	6.8	7.4	7.5	7.5	7.5
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jet Propulsion Laboratory							
NOA\$	2.9	3.5	3.2	3.2	3.6	3.6	3.9
Civil Service FTEs	28.0	28.0	31.0	37.0	37.0	37.0	37.0
Support Contractor EPs	14.0	15.0	16.0	17.0	17.0	17.0	17.0
Johnson Space Center							
NOA\$	73.7	97.1	96.6	100.5	106.4	105.7	105.9
Civil Service FTEs	40.0	40.0	41.0	47.0	47.0	47.0	47.0
Support Contractor EPs	169.3	160.9	142.9	138.9	144.9	142.9	142.9
Kennedy Space Center							
NOA\$	2.6	2.7	3.0	2.7	2.2	2.2	2.2
Civil Service FTEs	4.0	6.0	7.0	6.0	6.0	6.0	6.0
Support Contractor EPs	16.3	22.3	21.0	20.0	17.0	17.0	17.0
Marshall Space Flight Center							
NOA\$	0.2	1.4	13.4	13.4	13.7	13.6	13.6
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## Biomedical Research and Countermeasures

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
TOTAL							
NOA\$	56.9	77.9	75.5	76.5	79.1	78.0	78.5
Civil Service FTEs	17.0	16.0	15.0	15.0	15.0	15.0	15.0
Support Contractor EPs	66.6	84.4	64.1	53.1	53.1	54.1	54.1
Ames Research Center							
NOA\$	1.1	0.5	0.3	0.3	0.3	0.3	0.3
Civil Service FTEs	10.0	9.0	9.0	9.0	9.0	9.0	9.0
Support Contractor EPs	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Goddard Space Flight Center							
NOA\$	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headquarters							
NOA\$	3.4	4.8	3.8	4.3	4.3	4.3	4.3
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jet Propulsion Laboratory							
NOA\$	0.2	0.2	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Johnson Space Center							
NOA\$	51.7	71.8	70.8	71.3	73.8	72.7	73.2
Civil Service FTEs	6.0	6.0	5.0	5.0	5.0	5.0	5.0
Support Contractor EPs	64.2	81.0	61.0	50.0	50.0	51.0	51.0
Kennedy Space Center							
NOA\$	0.3	0.3	0.4	0.4	0.4	0.4	0.4
Civil Service FTEs	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Support Contractor EPs	1.3	2.3	2.0	2.0	2.0	2.0	2.0
Marshall Space Flight Center							
NOA\$	0.0	0.2	0.2	0.2	0.2	0.2	0.2
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## Advanced Human Support Technology

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
TOTAL							
NOA\$	30.2	30.9	31.1	32.2	33.3	33.8	33.8
Civil Service FTEs	73.0	77.0	84.0	95.0	95.0	95.0	95.0
Support Contractor EPs	114.3	97.6	104.6	102.6	104.5	102.5	102.5
Ames Research Center							
NOA\$	4.5	3.8	3.3	3.1	3.1	3.1	3.1
Civil Service FTEs	14.0	16.0	16.0	16.0	16.0	16.0	16.0
Support Contractor EPs	23.7	23.7	23.7	23.7	23.6	23.6	23.6
Goddard Space Flight Center							
NOA\$	2.5	2.0	0.4	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headquarters							
NOA\$	1.6	2.3	2.6	2.6	2.6	2.6	2.6
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jet Propulsion Laboratory							
NOA\$	2.6	3.2	3.1	3.2	3.5	3.6	3.8
Civil Service FTEs	28.0	28.0	31.0	37.0	37.0	37.0	37.0
Support Contractor EPs	14.0	15.0	16.0	17.0	17.0	17.0	17.0
Johnson Space Center							
NOA\$	16.8	17.3	19.0	21.0	22.3	22.8	22.5
Civil Service FTEs	28.0	28.0	31.0	37.0	37.0	37.0	37.0
Support Contractor EPs	61.6	38.9	45.9	43.9	48.9	46.9	46.9
Kennedy Space Center							
NOA\$	2.2	2.3	2.5	2.2	1.7	1.7	1.7
Civil Service FTEs	3.0	5.0	6.0	5.0	5.0	5.0	5.0
Support Contractor EPs	15.0	20.0	19.0	18.0	15.0	15.0	15.0
Marshall Space Flight Center							
NOA\$	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0



## Space Medicine Research

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
TOTAL							
NOA\$	7.3	10.2	8.2	11.1	13.2	13.1	13.1
Civil Service FTEs	6.0	8.0	7.0	9.0	9.0	9.0	9.0
Support Contractor EPs	43.5	41.0	36.0	45.0	46.0	45.0	45.0
Ames Research Center							
NOA\$	0.0	0.5	0.5	2.0	2.0	2.0	2.0
Civil Service FTEs	0.0	2.0	2.0	4.0	4.0	4.0	4.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goddard Space Flight Center							
NOA\$	0.7	0.4	0.3	0.3	0.1	0.1	0.1
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headquarters							
NOA\$	1.0	1.0	0.4	0.4	0.6	0.6	0.6
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jet Propulsion Laboratory							
NOA\$	0.0	0.1	0.1	0.0	0.1	0.1	0.1
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Johnson Space Center							
NOA\$	5.3	8.0	6.8	8.2	10.3	10.2	10.2
Civil Service FTEs	6.0	6.0	5.0	5.0	5.0	5.0	5.0
Support Contractor EPs	43.5	41.0	36.0	45.0	46.0	45.0	45.0
Kennedy Space Center							
NOA\$	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marshall Space Flight Center							
NOA\$	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0



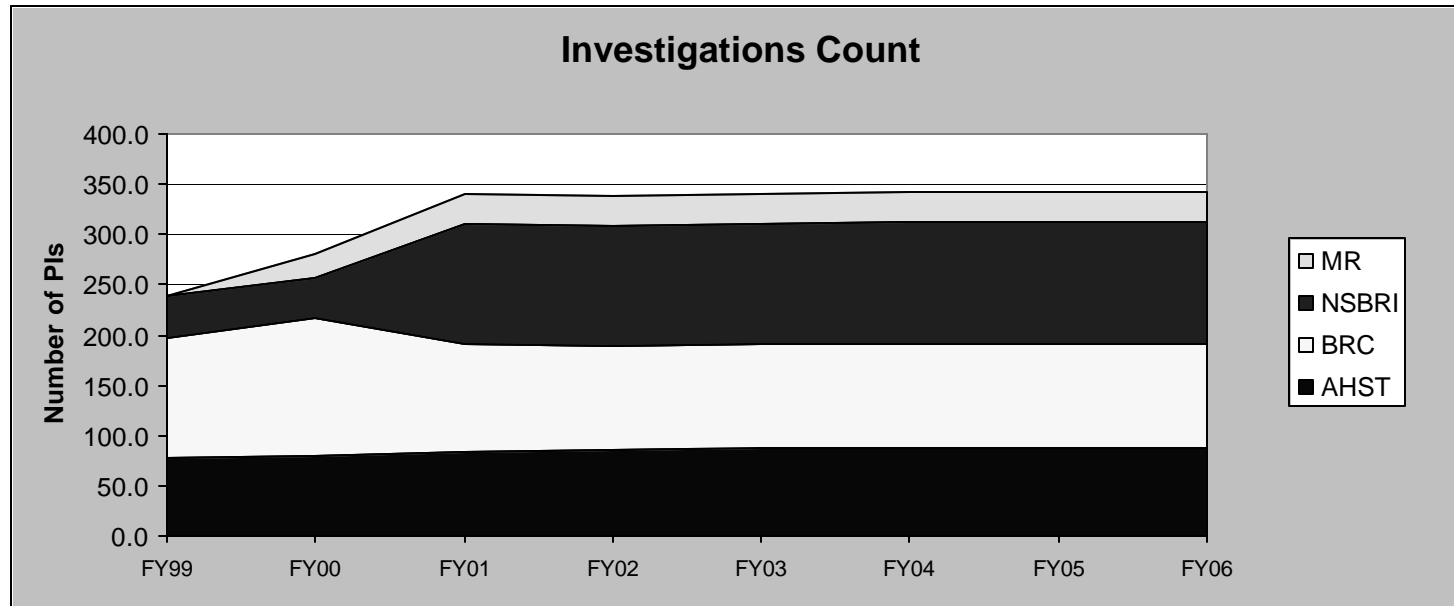
## Microgravity Research

	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
TOTAL							
NOA\$	0.0	1.0	13.0	13.0	13.3	13.2	13.2
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ames Research Center							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goddard Space Flight Center							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Headquarters							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Jet Propulsion Laboratory							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Johnson Space Center							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kennedy Space Center							
NOA\$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Civil Service FTEs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Support Contractor EPs	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Marshall Space Flight Center							
NOA\$	0.0	1.0	13.0	13.0	13.3	13.2	13.2
Civil Service FTEs							
Support Contractor EPs							



## HSLSPO Congressional Earmarks

	FY96	FY97	FY98	FY99	FY00
o BIOMEDICAL RESEARCH AND COUNTERMEASURES					
- LOMA LINDA UNIVERSITY	4.5	4.0	5.5	6.5	3.7
- Directed towards research in Neuroscience					
- Provides funding for beam time					
- FERMI LABORATORY					1.8
- Technology development effort					
- Continuing to work with Fermi Labs to develop the necessary research proposals before proceeding.					
- This effort has been delayed by one year.					
o ADVANCED HUMAN SUPPORT TECHNOLOGY					
- TEXAS TECH UNIVERSITY GARDEN MACHINE					0.9
Peer review panel was formed and reviewed the proposal. A cooperative agreement was drafted and is ready for signature, pending resolution of U.S. citizenship requirement. Resolution is expected shortly. For additional information contact Don Henninger					
o MISSION INTEGRATION					
- UNIVERSITY OF MISSOURI					



	<u>FY99</u>	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
<b>Congressional Metric</b>	<b>234.0</b>	<b>262.0</b>	<b>303.0</b>	<b>303.0</b>	<b>303.0</b>	<b>303.0</b>	<b>303.0</b>	<b>303.0</b>
BRC	157.0	185.0	224.0	224.0	224.0	224.0	224.0	224.0
AHST	77.0	77.0	79.0	79.0	79.0	79.0	79.0	79.0
<b>TARGET</b>	<b>238.0</b>	<b>281.0</b>	<b>341.0</b>	<b>339.0</b>	<b>341.0</b>	<b>342.0</b>	<b>342.0</b>	<b>342.0</b>
MR	0.0	24.0	30.0	30.0	30.0	30.0	30.0	30.0
BRC TOTAL	160.0	178.0	227.0	224.0	224.0	224.0	224.0	224.0
BRC	119.0	137.0	107.0	104.0	104.0	104.0	104.0	104.0
NSBRI	41.0	41.0	120.0	120.0	120.0	120.0	120.0	120.0
AHST	78.0	79.0	84.0	85.0	87.0	88.0	88.0	88.0



## Bioastronautics Ground Facility Utilization

	<u>FY98</u>	<u>FY99</u>	<u>FY00</u>	<u>FY01</u>	<u>FY02</u>	<u>FY03</u>	<u>FY04</u>	<u>FY05</u>	<u>FY06</u>
<b>Total</b>			<b>10.6</b>	<b>14.6</b>	<b>14.9</b>	<b>6.1</b>	<b>5.1</b>	<b>5.1</b>	<b>5.1</b>
BAF (JSC/BRC)	0.3	3.5	9.0	9.5	9.8	1.0			
BIO-Plex (JSC/ALS)				3.5	3.5	3.5	3.5	3.5	3.5
Biological Processes Development Labs (KSC/ALS)			0.3	0.3	0.3	0.3	0.3	0.3	0.3
Advanced Life Support Development Lab (ARC/ALS)			0.9	0.9	0.9	0.9	0.9	0.9	0.9
Plant Systems / Water Recovery Lab (JSC/ALS)			0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bioastronautics Facility (JSC)									

\$'s in work



## **Bioastronautics Initiative with 30% Augmentation**

- Initiate new tasks in advanced medical systems with support from NSBRI and ARC
- Sustain a research base directed towards addressing the Bioastronautics Critical Path issues.
- Continue a focused flight research project utilizing the resources of both the Shuttle and Station.
- Maintains funding for Booster Applications Facility development for radiation research at Brookhaven National Laboratory with a planned utilization start in 2003
- Maintains funding for the development of the BIO-Plex and a planned utilization in FY2003 with a 120-day closed environment test
- Expands the funding to the NSBRI for research efforts within the 12 consortium teams
- Expands the NSCORT in the area of Advanced Life Support
- Add a new joint effort between NASA and NCI on new technologies in clinical medicine and biomedical research
- Initiate the Center for Biology Inspired Technology effort
- Add a second Biologically Inspired Technology Research NRA, starting in FY01
- Expands the research in the areas of Space Human Factors Engineering and Advanced Food Technology, starting in FY2003.
- Initiates new tasks in microgravity safety applications including evaluations in new radiation shielding materials.
- Provides for the funding for the third party construction and outfitting of a new Bioastronautics Facility



## **What is not included in this budget**

- Robust means of pursuing Bioastronautics Objectives of expanded safe human performance in LEO and beyond
- Increase in the number of research investigations supporting the PI metric.
- Request for a 1% contingency tax to be held at HQ in addition to HICS and AADF
- Advanced Research in Countermeasures
  - Example: No funds to initiate dedicated research in supplemented Artificial Gravity to determine the utility of some percentage of AG as a potential countermeasure
- Core laboratory funding to assure JSC labs available for core BR&C efforts
- Expanded radiation research effort for full utilization in pursuit of requirements and capability
- Expanded education and outreach effort
- Ability to fully utilize shuttle research opportunities (ie, R3, R4)



## **Forward Work**

- Final documentation of Mark in databases and at supporting centers
- Resolution of the Bioastronautics Facility
- Coordination on upcoming NRAs for BR&C, MR, and AHST
- Finalization of the plans for 107 and R2 missions



## **Back-up & junk**



## Major Thrusts of Bioastronautics

- **Space Medicine & Health Care Systems**
  - Provide medical care which has been adapted for autonomous space travel
  - A database of clinical norms for medical care in microgravity and reduced-gravity environments
  - Cybernetically assisted surgical environment for real-time care rendering in space flight and virtual training activities
- **Habitation/Environmental Health Systems**
  - Habitation systems capable of supporting humans without Earth resupply for up to 1000 days
  - Robust EVA technology for frequent space and surface activity
  - Radiation protection technology & protocols for LEO, deep space and extra-planetary environments
  - Advanced environmental control system capable of autonomous decision making and adjustment
- **Human Adaptation/Countermeasures**
  - Validated countermeasures (mechanical, procedural, and pharmaceutical) for physical and mental health throughout the course of long-duration missions (up to 1000 days)
  - Decision on the usefulness and form of an artificial gravity countermeasure

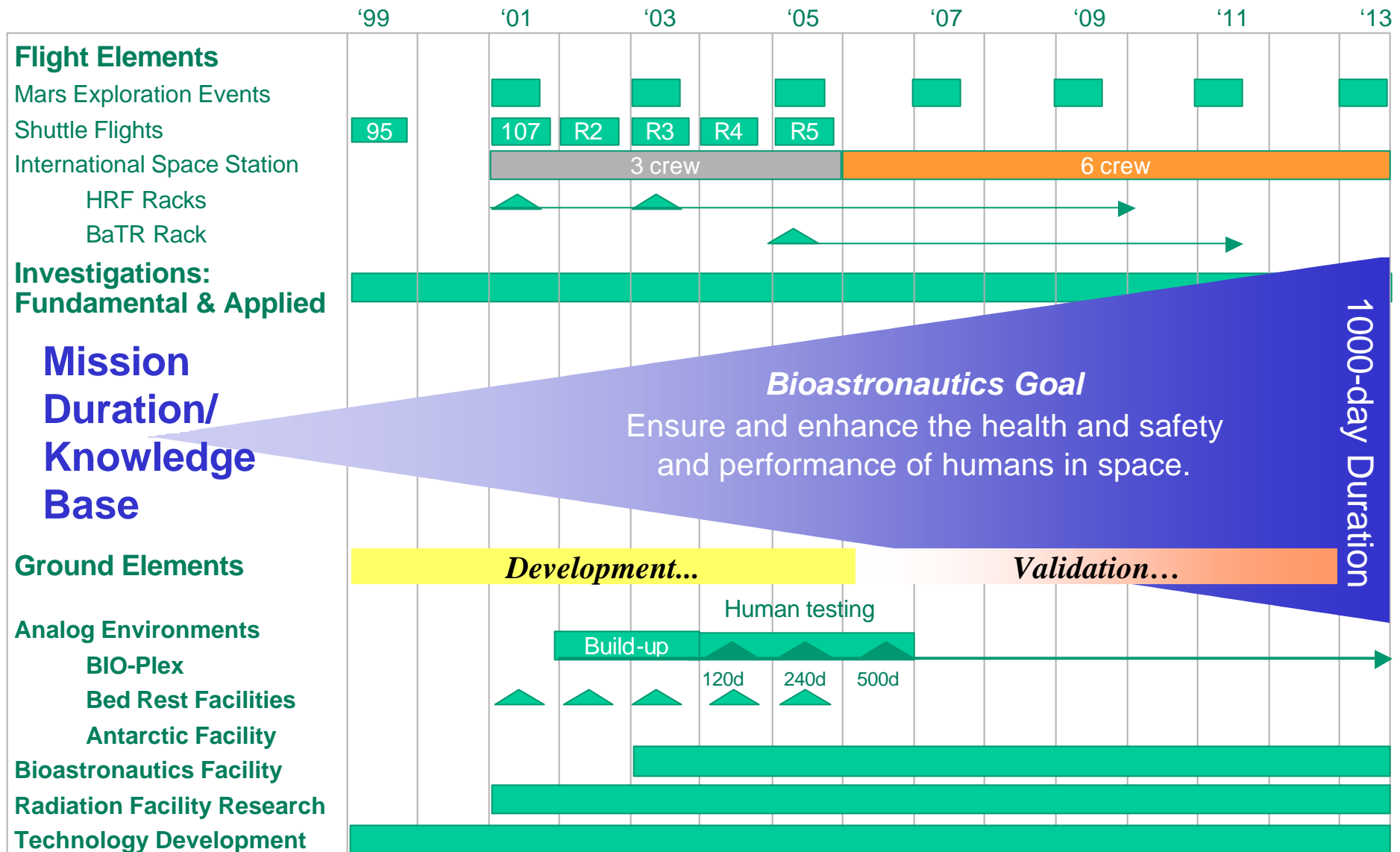


## **Significant Actions From Code U**

- Establish a set of performance targets and indicators for BRC and AHST for FY 2001 through 2006
- Continue to increase the funding for investigations to 60% by 2003.
- Lead Centers for AHST, BRC and FB are to assume a 1% contingency held at Headquarters for unanticipated interagency advanced planning activities.
- Lead Centers are to refine the estimates of additive cost for PES and carrier lease to the Agency for the R2 mission, and that this mission would fly either at the end of CY 01 or early CY 02.
- HSLSPO is tasked to recommend the highest priority long-duration space flight critical health care and safety issues to be addressed through the Bioastronautics Initiative and provide the schedule for resolving these critical issues.
- Provide a plan for BRC to transfer all research, including the operation of radiation facilities, to the National Space Biomedical Research Institute (NSBRI) in FY 2002 (except the Booster Applications Facility construction).
- Proposals for the expanded NSCORT will be solicited in the mid-2001 time frame, will include an HBCU/OMU partner, and will be funded at a level of \$2.0M per year from within the AHST budget beginning January 1, 2002.



## Bioastronautics Initiative – Program Elements Strategic Roadmap





## **Implementation Status**

- Developing balanced Bioastronautics program based on total resource availability
- Major reformulation of JSC Space and Life Sciences Directorate – in progress
- Increased roles, responsibilities, and resources for the NSBRI
- Developing relationships with other NASA centers to participate in implementation
- Initiated planning for a Bioastronautics Facility



## Program Status

- Initial strategic and tactical planning completed
  - Implementation of selected elements has been initiated
- Major restructuring of the biomedical program required to achieve safe space flight has been identified
  - Provides an integrated program focused on requirements and deliverables providing crew safety, health and performance
  - Significant utilization of non-NASA entity (NSBRI)
  - Transfer of responsibilities/functions from HQ to JSC and to NSBRI
- Completing tactical planning and beginning full implementation
  - Focus on supporting ISS human operations and research
  - All elements in place by end of FY00
- Extent of augmentation (if any) is under review
  - Regardless of augmentation, we believe a Bioastronautics concept provides the framework for a safer, healthier and more productive human space flight program



**AHST**



## **Project Content Summaries**

### **ADVANCED LIFE SUPPORT (ALS) SYSTEMS**

- Will be required for future human space exploration missions
- Will provide self-sufficiency for air, water and food
- Will dramatically reduce amount of resupply required for these consumables
- Research areas:
  - Atmosphere revitalization
    - CO<sub>2</sub> removal and reduction, O<sub>2</sub> replacement, trace contaminant control
  - Water recovery and management
    - Urine, hygiene and wash wastewater processing
  - Waste management
    - Fecal and urine collection and pretreatment, waste processing
  - Food production
    - Crop production, pr, and storage

### **ADVANCED ENVIRONMENTAL MONITORING AND CONTROL (AEMC)**

- Reliability monitor gas, liquid, and microbial constituents of a closed loop life support system
- Autonomously analyze and control these constituents to maintain human and system health safely
- Research areas
  - Air monitoring (chemicals)
    - Sampling biologically inspired sensor technologies, miniaturization
  - Water monitoring (chemicals)
    - Sampling biologically inspired sensor technologies, miniaturization
  - Microbial monitoring
    - Sampling biologically inspired sensor technologies, miniaturization



## Project Content Summaries

### SPACE HUMAN FACTORS ENGINEERING (SHFE)

- Focuses on the role of humans in complex systems, the design of equipment and facilities for human use, and the development of environments conducive to comfort and safety
- Research areas:
  - Ergonomics and anthropometrics
    - Habitability, safety, tools and equipment
  - Human interaction with information and automation systems
    - Interfaces, displays and controls, human/machine function allocation
  - Training
    - Training for frequent tasks
  - Workload and performance
    - Workload monitoring and assessment, schedule planning and optimization

### ADVANCED EVA (AEVA)

- Will provide mobility for exploration, life support, environmental protection and external work on spacecraft and the exploration environment
- Reduces amount of resupply, system weight, demand on crew time during the mission and ground preparation time prior to mission
- Research areas
  - Atmosphere revitalization
    - Portable CO<sub>2</sub> and humidity removal, O<sub>2</sub> replacement, trace contaminant control
  - Environmental protection
    - Mechanical threat protection (radiation, MMOD, dust, contamination and puncture), portable thermal control, pressure
  - EVA human factors
    - Suit interactions with airlock, vehicle control stations (rovers, space vehicles), robots



## **Project Content Summaries**

### **ADVANCED FOOD TECHNOLOGY**

- Focuses on research and development work that will enable the provision of a nutritious and safe food system for an exploration-class mission
- Research areas:
  - Food processing
    - Equipment and procedures for processing of BIP-Plex crops into ingredients for food preparation
  - Food packaging
    - Advanced food packaging to extend shelf-life and reduce weight, volume and waste for an exploration-class food system
  - Food preservation
    - Research into methods for extending shelf-life of food products to meet the estimated 5-year shelf-life requirements for an exploration-class mission



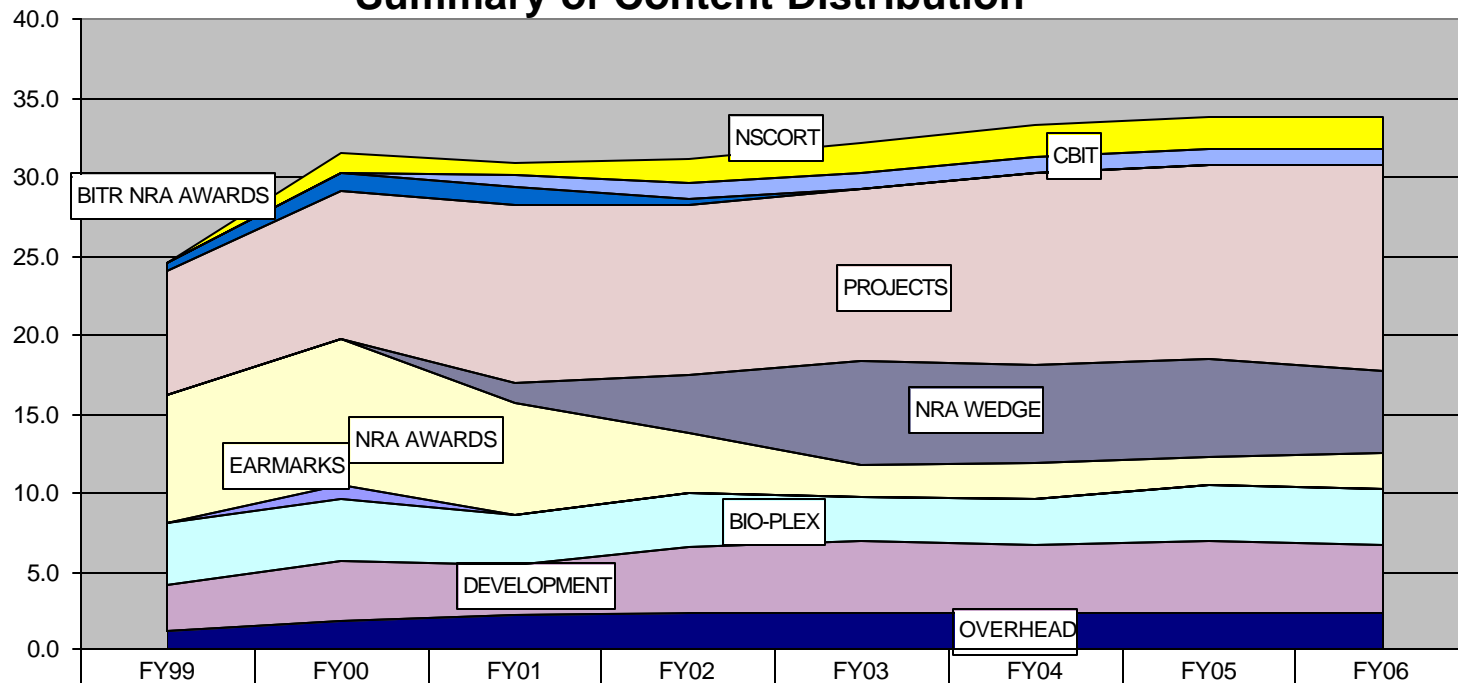
## AHST Issues

- HQ wants \$1.0M additional to FY01 NRA budget
- Resolution requires major reprogramming; no reserves, no fat
- Candidates are:
  - Biology-Inspired Technology – delay funding of center by one year (-\$0.5M)
  - Delay environmental CSC one year (-\$0.5M)
  - Transfer ALS physical – chemistry research from ARC to JSC (-\$0.8M)
- Inadequate funding for midrange TRLs for ALS
  - These items will cost \$500K-\$750K each
  - PI count based upon \$150K each
  - BIO-Plex need these technologies to support FY03 testing
  - Overguidelines has necessary funding



## POP 00 Recommended Budget Content – AHST

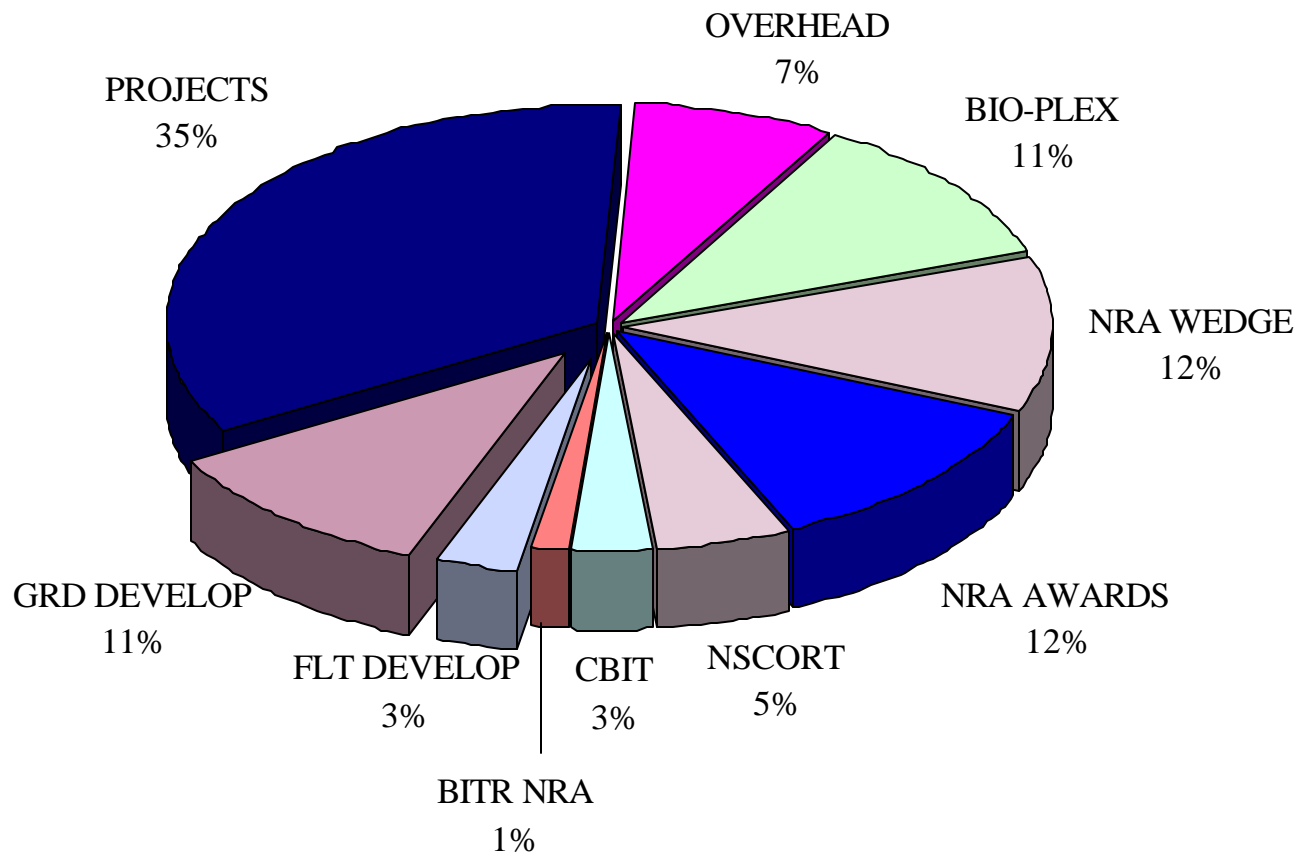
### Summary of Content Distribution



	FY99	FY00	FY01	FY02	FY03	FY04	FY05	FY06
TOTAL	24.5	31.5	30.9	31.1	32.2	33.3	33.8	33.8
■ NSCORT	0.0	1.2	0.8	1.5	2.0	2.0	2.0	2.0
■ CBIT	0.0	0.0	0.8	1.0	1.0	1.0	1.0	1.0
■ BITR NRA AWARDS	0.5	1.2	1.2	0.4	0.0	0.0	0.0	0.0
■ PROJECTS	7.9	9.4	11.2	10.7	10.9	12.2	12.3	13.0
■ NRA WEDGE	0.0	0.0	1.2	3.7	6.5	6.2	6.2	5.2
■ NRA AWARDS	8.0	9.2	7.1	3.7	2.0	2.2	1.8	2.3
■ EARMARKS	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0
■ BIO-PLEX	4.0	3.9	3.2	3.5	2.9	2.9	3.5	3.5
■ DEVELOPMENT	3.0	3.9	3.2	4.3	4.6	4.5	4.7	4.5
■ OVERHEAD	1.1	1.8	2.2	2.3	2.3	2.3	2.3	2.3



## AHST POP 00 Recommended Budget – FY02 Content



BIO-PLEX	3.5
NRA WEDGE	3.7
NRA AWARDS	3.7
NSCORT	1.5
CBIT	1.0
BITR NRA	0.4
FLT DEVELOP	1.0
GRD DEVELOP	3.3
PROJECTS	10.7
OVERHEAD	2.3
<b>TOTAL</b>	<b>31.1</b>

<b>Ground Development:</b>	<b>3.3</b>
- Bioastro-Habit	0.5
- Biosensor Tech Appl Dev	0.6
- Environ Mgt Sys CSCs	0.5
- Com'l Sp Ctr for Food	0.5
- Adv Biology Ctr	0.1
- Future IPAs	0.4
- SHFE Support	0.3
- Adv Food Prod	0.4
<b>Flight Development:</b>	<b>1.0</b>
- Tillitson Task Supt	0.3
- Levine Task Supt	0.2
- Flt PL Def Supt	0.5
<b>Projects</b>	<b>10.7</b>
- ALS @JSC	4.1
- ALS @KSC	1.3
- ALS @ARC	1.7
- AEMC	3.1
- SHFE	0.5



## **Laboratories** ***Integrate Center Strengths***

### **JSC**

Crew re-habilitation  
and training  
Baseline data  
collection  
Biomedical &  
clinical research  
Advanced systems  
in medicine, life  
support, & safety  
Biotechnology &  
bioengineering

### **JPL**

Nano-  
technology  
Human-  
machine  
interfaces

### **ARC**

Cyber-  
medicine  
Medical  
informatics  
Human-  
machine  
interfaces

### **MSFC/GRC**

Materials  
Combustion  
Fluids  
Commercial

Pillars\_JAR\_N



## **NASA-NCI Research Program**

**Overall leadership:** NASA Chief Scientist, Dr. K. Olsen

**Programmatic Responsibility:** Microgravity Research Division / UG  
Budget currently carried under MRPO/Multidiscipline/Bioastronautics

### **FY 01 Plan:**

- **NASA/NCI Joint NRA** : \$3M NASA funding + \$3M NCI funding
  - Target release date: September 2000
- **NASA Biomolecular Systems NRA:** \$3M NASA funding
  - Target release date: July 2000
  - Target Selections: February 2001
- **NASA Directed Pilot Projects at NASA Centers:** \$4M
  - Process and format in work by UG



## **NSBRI Activities**



## **Increased Scope of NSBRI Activities**

- New requests for research proposals are open to all national research institutions
- Discipline research teams have been increased from 8 to 12 to include cross-cutting and integrative functions (FY00)
- Consortium schools were increased from original 7 to 12 through a competitive selection process including “reverse site visits” (FY00)
- Core funding increased (Increases began in FY99)
- Four international affiliations signed to date:
  - Germany’s DLR (January 1998)
  - France’s MEDES (Toulouse) (June 1999)
  - Italy’s Politecnico di Milano (April 1999)
  - Russia’s IBMP (Active since 1999)
- Role in countermeasure development
  - Basic research
  - Countermeasure development
  - Countermeasure demonstration (shared responsibility with NASA)



## **Present Roles of NSBRI**

- Issues annual Research Announcements in discipline specific research
- Engaged in the scientific discipline research and leadership collaboratively with NASA
- Institute members have been selected as ground and flight investigators
  - Flight Investigation management is led by JSC
- Special projects with the Institute include development of research associated with benefits from Artificial Gravity
- Developing techniques and tools to utilize and maximize research data archived to date



## Summary

- NSBRI will assume an increasingly important and central role in NASA's overall biomedical research program
- The NSBRI model is evolving as one that is directly applicable to the next generation workforce concept for NASA
- Limitations are seen to be only those roles that involve direct flight responsibility and accountability to senior NASA management



## Outcome

- Enhanced ability to deliver crew health care
- Ability to understand and handle the human biomedical risks that accompany space flight
  - Significant participation by the external scientific community
  - Requirements to guide programmatic prioritizations and decisions (cost/benefit analyses)
  - Improved metric tracking of progress and deliverables
- Revitalize the HEDS mission through enhanced national and international partnerships
- Enhanced education and outreach activities



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